

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.</small>					
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 04-23-2013		2. REPORT TYPE Master of Military Studies Research Paper		3. DATES COVERED (From - To) September 2012 - April 2013	
4. TITLE AND SUBTITLE The Need for US Coast Guard Underwater Mission Development				5a. CONTRACT NUMBER N/A	
				5b. GRANT NUMBER N/A	
				5c. PROGRAM ELEMENT NUMBER N/A	
6. AUTHOR(S) Bertsch, Fred S., Lieutenant Commander, USCG				5d. PROJECT NUMBER N/A	
				5e. TASK NUMBER N/A	
				5f. WORK UNIT NUMBER N/A	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC Command and Staff College Marine Corps University 2076 South Street Quantico, VA 22134-5068				8. PERFORMING ORGANIZATION REPORT NUMBER N/A	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A				10. SPONSOR/MONITOR'S ACRONYM(S) N/A	
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER N/A	
12. DISTRIBUTION AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES N/A					
14. ABSTRACT Subsurface activity continues to expand with advances in technology such as increasing use of unmanned underwater vehicles and proliferation of fiber optic cables, raising the level of human interactions in the underwater environment. Besides the benefits from the increasing interaction come substantial threats and hazards ranging from potential terrorism to environmental disasters. As one of the nation's leading maritime organizations, the US Coast Guard possesses unique roles and responsibilities essential to addressing these threats. From counter narcotic operations to regulatory oversight, the Coast Guard will play an important role in mitigating the underwater hazards. Eventually, the expanding underwater threats will require responses to protect the nation, its citizens, its resources, and the global economy. Potential solutions abound to address the threats and hazards, but incorporating the technological solutions requires capacity and capability. The Coast Guard needs to ensure its personnel are properly prepared to meet this developing challenge through knowledge and expertise while building partnerships and utilizing advances in technology.					
15. SUBJECT TERMS Coast Guard, USCG; underwater; submarines; remotely operated vehicles, ROVs; unmanned underwater vehicles, UUV					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 37	19a. NAME OF RESPONSIBLE PERSON Marine Corps University / Command and Staff College
a. REPORT Unclass	b. ABSTRACT Unclass	c. THIS PAGE Unclass			19b. TELEPHONE NUMBER (Include area code) (703) 784-3330 (Admin Office)

*United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068*

MASTER OF MILITARY STUDIES

TITLE: The Need for US Coast Guard Underwater Mission Development

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

AUTHOR:

LCDR Fred Bertsch
CG #10
22 March 2013
MMS Final Draft

AY 12-13

Mentor and Oral Defense Committee Member: Craig Swanson PhD
Approved: [Signature]
Date: April 17, 2013

Oral Defense Committee Member: CDR Russell Evans
Approved: [Signature]
Date: April 17 2013

Executive Summary

Title: The Need for US Coast Guard Underwater Mission Development

Author: Lieutenant Commander Fred Bertsch, United States Coast Guard

Thesis: Ultimately, careful analysis of the threats and hazards presented by expansions in underwater activity that overlap with Coast Guard roles and responsibilities necessitates the need for the Coast Guard to begin developing an underwater mission.

Discussion: Activity within the underwater realm of the maritime domain continues to expand. Advances in technology such as increasing use of unmanned underwater vehicles, proliferation of fiber optic cables, and observation posts on the ocean floor will raise the level of human interactions with the underwater environment. Besides the additional benefits associated with the increasing interaction come substantial threats and hazards ranging from potential smuggling or terrorism to extensive environmental disasters. As one of the nation's leading maritime organizations, the US Coast Guard possesses unique roles and responsibilities essential to addressing these threats. From counter narcotic operations to regulatory oversight and management of boating safety, the Coast Guard will play an important role in mitigating the hazards posed by the expansion in underwater activities. It is important for the Coast Guard to identify the potential requirements for an underwater mission and quickly develop the means to counter the threats. While substantial threats exist, countless methods of addressing the challenges also exist. The Coast Guard needs to ensure its personnel are properly prepared to meet this developing challenge through knowledge and expertise while building partnership efforts and utilizing advances in technology.

Conclusion: Eventually, the expanding underwater threats and hazards will require responses to protect the nation, its citizens, its resources, and the global economy. Potential solutions abound and are likely to increase to address the threats and hazards, but incorporating the advancements and technological solutions requires capacity and capability. Because the Coast Guard's roles and responsibilities address safety, security and stewardship issues in the maritime domain, the Coast Guard needs to begin developing underwater mission capabilities to handle the challenges associated with the expanding activity in the underwater environment.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

QUOTATION FROM, ABSTRACTION FROM, OR REPRODUCTION OF ALL OR ANY PART OF THIS DOCUMENT IS PERMITTED PROVIDED PROPER ACKNOWLEDGEMENT IS MADE.

Table of Contents

	Page
EXECUTIVE SUMMARY	i
DISCLAIMER	ii
TABLE OF CONTENTS.....	iii
LIST OF ILLUSTRATIONS.....	iii
PREFACE	iv
INTRODUCTION	1
IMPORTANCE OF THE MARITIME DOMAIN.....	2
EXPANSION OF UNDERWATER ACTIVITY	3
THREATS AND HAZARDS FROM UNDERWATER ACTIVITIES.....	8
COAST GUARD ROLES AND RESPONSIBILITIES FOR UNDERWATER ISSUES.....	11
POTENTIAL SOLUTIONS FOR COAST GUARD UNDERWATER MISSIONS	19
CONCLUSION.....	25
BIBLIOGRAPHY.....	30

List of Illustrations

	Page
Figure 1. Russian Miniature Submarine	4
Figure 2. US Navy Remotely Operated Vehicle.....	5
Figure 3. Remotely Operated Vehicle <i>Hercules</i>	6
Figure 4. Interdicted self-propelled, semi-submersible	14
Figure 5. Self-propelled, semi-submersible interdicted by USCGC <i>Midgett</i>	15

Preface

Intrigued by the use potential for growth in subsurface activity over the next few decades, I undertook this research to assess the potential for the Coast Guard missions to expand into the underwater environment. The idea first captured me when skimming the *US Coast Guard Evergreen II Project Report*, which identifies the potential changes in the maritime domain that might challenge Coast Guard operations by 2020. As an effort to identify and prepare for potential future challenges, the strategic project noted that expansion of underwater activity could necessitate development of a Coast Guard underwater mission. Throughout my research and analysis, I was amazed to discover the extensive amount of underwater activity people and companies already engage in and how this growth influences aspects of everyday life. While I believe the future will dictate that the Coast Guard and other agencies become actively engaged in the underwater environment to combat the hazards and threats, I am more surprised that more action has not already taken place. It is my hope that this project will spur further discussion and engagement in the topic and foster a proactive approach to dealing with the future possibilities.

This project required a significant amount of time and effort by numerous other people. I would like to thank all those involved in the process, both formally and informally, who gave me great ideas, conducted reviews, or just talked at length about the project with me. I especially would like to thank my project mentor Dr. Swanson for the great feedback, helpful discussion, and overall guidance navigating me through the process. Additionally, I greatly appreciate my military faculty advisor Lt. Col. Sullivan for support, guidance, and encouragement throughout the project and the entire year. Finally, I cannot express my gratitude and love enough for my wonderful and supportive family, headed by my wife Jessica, who has been understanding, supportive, and when needed critical to keep me on track, motivated, and successful. Thank you.

Introduction

Activity within the underwater realm of the maritime domain continues to expand. The potential changes in underwater capabilities and resulting human interactions with this element of the maritime environment will present both additional benefits and new hazards. As one of the nation's leading maritime organizations, the US Coast Guard possesses unique roles and responsibilities essential to addressing these threats. In a strategic project envisioning necessary missions in future environments, the US Coast Guard hypothesized that increased activity in the subsurface domain would necessitate the development of an underwater mission for the Coast Guard.¹ Identifying potential advancements that are opening the underwater environment to usage by commercial, recreational, scientific, and criminal elements as well as the military, the Coast Guard anticipates the requirement for underwater responsibilities and capabilities within its missions in the next 20 years.² Critical analysis is necessary to determine whether this is appropriate. Expanding the Coast Guard mission set to include underwater efforts would require leveraging partnerships and expanding current knowledge, capabilities, and resources. However, as stewards of the American public and constrained by resources, the Coast Guard should not invest time and effort in this pursuit if an underwater mission is not appropriate.³ Conversely, if incorporating an underwater mission is appropriate, then the Coast Guard quickly and efficiently needs to pursue development of the capability to ensure it is properly prepared when called upon. Ultimately, careful analysis of the threats and hazards presented by expansions in underwater activity that overlap with Coast Guard roles and responsibilities necessitates the need for the Coast Guard to begin developing an underwater mission.

Seeking to analyze the appropriateness of the underwater mission for the Coast Guard, this paper will first discuss the importance of the maritime domain followed by an examination

of growth and advancements in underwater activities. Building on the expansion of underwater activities, the second section will analyze the potential threats and hazards associated with the underwater operations. Next, the paper will address how these fit into the roles and responsibilities of the Coast Guard and assess the necessity for the Coast Guard to develop an underwater mission in response to the threats and hazards. Finally, the paper will conclude with potential solutions to address the threats and hazards. Examining the roles and responsibilities of the Coast Guard in light of the expanding threats and hazards within the underwater domain illustrates the importance for the Coast Guard to develop the personnel and capabilities to execute underwater missions.

Importance of the Maritime Domain

Covering approximately 72 percent of the planet's surface, water plays an integral part of life for human civilization.⁴ Besides being essential to sustaining life, water serves critical roles within society through the maritime environment. Comprised of the oceans, lakes, rivers, and connecting waterways, the maritime environment facilitates the world's economic system, harbors vast resources, provides borders, and possesses substantial potential for future opportunities through the majority of still unexplored regions on earth.⁵ People have relied on the maritime environment for transportation throughout history and this trend continues with millions of people using maritime modes of transportation each year, both on daily commutes or vacations.⁶ Beyond transportation of people, the maritime environment serves as a critical link in the global economy.⁷ Providing an efficient and effective means to transport large quantities of goods cheaply, the maritime transportation system connects the world's landmasses facilitating globalization.⁸ Over 90 percent of the world's commerce in volume currently travels

via the maritime transportation system at one point in the supply chain.⁹ Protecting the global economy and providing maritime security remains a critical role for sovereign nations.¹⁰

In addition to transportation, the maritime domain also provides a plethora of resources. Humans have and continue to harvest marine animals ranging from fish to crustaceans for a variety of reasons including use as food.¹¹ Additionally, petroleum, natural gas, and other abundant natural resources within the maritime environment provide exploitation opportunities for humans to meet consumer demands.¹² Yet despite the extensive use of the maritime environment, much of the earth's oceans remain a mystery, not fully understood, explored, or exploited at depths.¹³ The oceans remained this way because of the extreme conditions and difficulties associated with underwater activities. However, as technology advances and the capabilities to explore, research, and exploit the maritime environment becomes more prevalent, this is likely to change rapidly, generating more potential for conflict among interested parties.¹⁴

Expansion of Underwater Activity

Modern advances in technology and science continue to make the underwater environment more accessible to everyone.¹⁵ Previously, underwater activities for people other than the military were generally limited to depths within 100 feet of the surface for typical divers. Now, using compressed air with normal scuba gear allows technical divers to submerge up to 190 feet and those using mixed gas systems can go upwards of 260 feet.¹⁶ While diving continues to push the boundary depths available for exploration, the volume of recreational diving throughout the world expands with more people enjoying the underwater realm.¹⁷ Expanding the depths of exploration even further, submarines open up additional possibilities.

Submarines fall into two categories. First large submarines primarily belong to the military with crews that remain underwater for long periods. The second category includes small submarines limited to a few people intended for exploration.¹⁸ Currently limited by expense, it is reasonable to expect small submarines to grow in numbers, potentially even used for commercial tourism and research, as technology becomes cheaper. The World Tourism Organization predicted that adventure travel, including exploring underwater sites, would emerge as one of the top five tourism products in the next decade.¹⁹ In 2007, a Russian explorer in a mini-submarine planted a Russian flag in the sea floor at the North Pole, demonstrating the capabilities of these vessels to conduct arduous operations in hazardous climates.²⁰



Figure 1. Picture from video of a Russian miniature submarine planting the Russian flag on the sea floor below the North Pole. (Photograph from *Reuters*, September 20, 2007.)²¹

The exploration of the maritime environment though occurs through other means besides diving and submarines. Remotely operated vehicles or unmanned underwater vehicles also provide the capability for underwater exploration, even accessing regions not considered a

decade ago.²² Various types of these vehicles are already in use throughout the commercial, academic, and military communities with different purposes, designs, and capabilities.²³ Militaries, including the US Navy, worked on developing remotely operated vehicles throughout the past three decades for numerous missions including counter mine operations.²⁴ Academics on the other hand, tend to utilize unmanned underwater vehicles for collecting environmental data, exploring underwater regions, and conducting research in the maritime environment.²⁵ Demonstrating the enhanced capabilities of autonomous underwater vehicles and the access to the subsurface environment they provide, researchers utilize the vehicles to collect data ranging from ice thickness in the Arctic to exploring deep-sea volcanic eruptions on the ocean floor.²⁶ Commercial usage of remotely operated vehicles ranges widely from conducting commercial salvage to offering consumers opportunities to explore the ocean remotely via virtual reality. For instance, a remotely operated vehicle controlled from a support ship provided video and photographs from the wreckage of the *Titanic*, accessing places unavailable to humans.²⁷ Remotely operated vehicles provide greater subsurface mobility and capability than ever before.²⁸ As a whole, these advances in technology are increasing the amount of human interaction with the underwater environment.



Figure 2. A US Navy self-propelled remotely operated vehicle able to take video and pictures. (Photograph from http://www.navy.mil/navydata/nav_legacy.asp?id=291 courtesy of Oceaneering Technologies, Upper Marlboro, MD.)²⁹

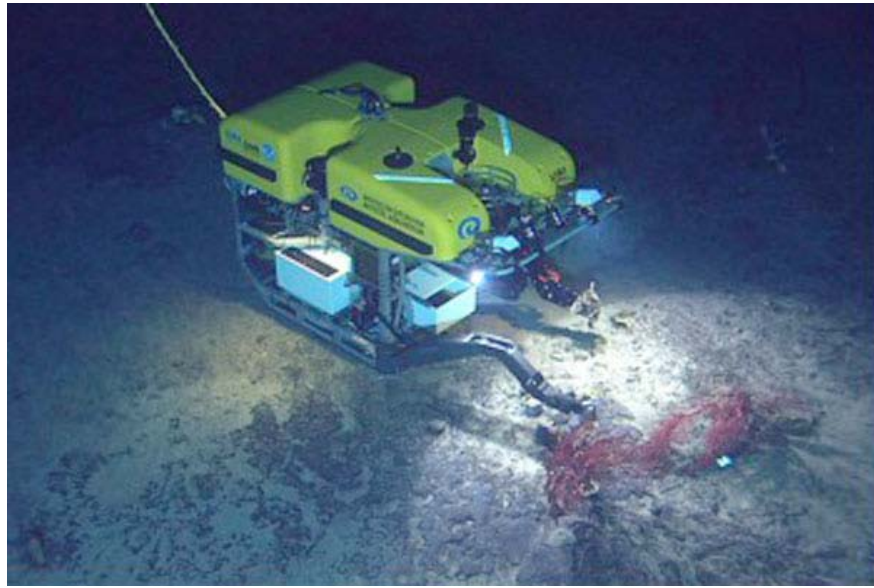


Figure 3. The remotely operated vehicle *Hercules* conducting recovery operations. (Photograph courtesy of the National Oceanic and Atmospheric Administration.)³⁰

While advances in technology open up additional areas, the advances also multiply the type of activities occurring within the underwater region.³¹ The abundant natural resources of the maritime environment, such as minerals and oil, remained unavailable for many years due to the inability to access them and safety concerns, but the accessibility provided by advancing technology now allows the possibility for harvesting. The potential for underwater harvesting of resources ranges widely in scope and area, from oil drilling in the Arctic to timber cutting flooded lakes.³² In the Arctic region, vast mineral deposits and millions of gallons of natural gas and oil await extraction.³³ Given the United States' energy needs, it is apparent that offshore oil development will continue in the future.³⁴ For instance, over the next two years Shell Oil Company plans to drill six wells at depths of 140 feet approximately 70 miles offshore in the Chukchi Sea.³⁵ At these proposed depths of water, the wells are more accessible to divers and remotely operated vehicles in the event of an emergency.³⁶ Within the Gulf of Mexico and off the Florida coast there remain numerous active or planned drilling operations, including ones off

the Cuban coast.³⁷ Natural resources accessible in the underwater environment also include renewable resources like fish or fresh water in the Arctic region.³⁸ Even submerged timber may provide the opportunity for extraction as the world's demand for wood grows.³⁹ These types of new underwater activities originate from advances in technology.

As technology progresses, undersea infrastructure will continue to expand. Already, underwater fiber optic communication cables and pipelines play an important role in providing information and energy.⁴⁰ Not only will these infrastructures continue their growth, but additional underwater infrastructures will also join the environment. Research efforts continue to incorporate underwater infrastructure ranging from sensors to observation areas in order to broaden the knowledge of marine environment and environmental sciences.⁴¹ Production on observatories and outposts on the ocean floor began in 2005 with numerous other research observation areas planned for development.⁴² One envisioned project is networking and wiring a tectonic plate for remote observation of movements.⁴³ Using fiber optic and submarine cables, scientists are working to expand connectivity and power supply to the ocean floor for future developments.⁴⁴ Providing connectivity and power on the ocean floor promotes opportunities for research to enhance the understanding of the underwater environment. Similar efforts may even lead to future underwater facilities that center on commercial aspects, such as energy production or resorts. With the continued push for alternative energy sources, it is likely that energy production from tidal, wave, or current sources will require expansion of infrastructure under the water's surface.⁴⁵ It is easy to estimate that future activities will blossom and exponentially increase as technology continues to facilitate increased human interaction with the underwater environment.

Threats and Hazards from Underwater Activities

The growing human interaction in the underwater environment also means heightened potential for threats and hazards.⁴⁶ These threats and hazards exist in numerous forms and varying aspects. One of the most profound threats will be the increase in loss of life and property since underwater activities contain an element of danger even more than activities above the surface. As more people engage in these activities, the likelihood and numbers of people in danger associated with these activities increases. The same argument also applies to the loss of property and damages. With more vessels and infrastructures underwater, the risk of property loss and damage increases.⁴⁷ In general, as activities underwater increase, the potential for human and property losses or damages increases.

Increased underwater activity also expands the threat to maritime transportation, the global economic system, and the nation's defense. As underwater operations become easier and more prolific, the risk of terrorist action against the maritime systems through underwater activity becomes more likely.⁴⁸ Already threats exist of divers attaching bombs or explosives to the bottom of vessels or piers with the intention of causing catastrophic damages, including economic and environmental impacts.⁴⁹ These types of threats expand with the increasing underwater capabilities.⁵⁰ Small submarines or remotely operated vehicles used by terrorists could facilitate a number of actions ranging from mining harbors or seizing control of vessels to sneaking people or weapons of mass destruction into the United States.⁵¹ Through underwater operations, terrorists also threaten subsurface infrastructures that significantly affect society. Damaging or destroying fiber optic communication lines not only significantly reduces information transfer, but also restricts economic transactions.⁵² Fishermen cutting cables

offshore of Vietnam for sale on the black market almost completely severed the country's connectivity.⁵³ Similarly, damaging underwater pipelines or electrical transmission lines could interrupt energy supply and production for critical areas.⁵⁴ Natural disasters also present potential devastating impacts as typhoons and earthquakes have severed communications lines, causing communication crises in various nations.⁵⁵

Besides terrorists, nation states and criminal organizations could also conduct these types of actions and use the expanding underwater operations to their advantage.⁵⁶ As nations steadily advance their underwater capabilities, underwater threats for war or sabotage become increasingly more possible and diverse. Within recent years, the US Navy began to identify the possibility for increased operations in the Arctic by other nations where the Navy has reportedly operated submarines previously against the USSR.⁵⁷ As an example of the increasing underwater threats from nation states, mini-submarines from North Korea have reportedly sunk a South Korean ship and inserted terrorists into South Korea.⁵⁸ Criminal organizations also use underwater operations to their advantage.⁵⁹ The use of self-propelled semi-submersibles and low profile vessels to smuggle drugs over the past decade along with evidence from captured vessels and smugglers also demonstrates the desire of drug trafficking organizations to use vessels capable of complete underwater submergence to avoid law enforcement.⁶⁰ Capable of holding thousands of tons of drugs, these submarines also present the opportunity to smuggle people, weapons, or other illicit elements via the maritime domain. Although currently limited by expertise and knowledge of submarine operations, increases in personal submarines, open knowledge and information sharing, and the availability of ex-military personnel from former USSR states suggests that these limitations are capable of being overcome.⁶¹ As criminal organizations expand their capabilities, the potential exists for them to provide support for terrorist

operations in exchange for money as well.⁶² Collaboration between criminal networks and terrorists present the possibility of smuggling terrorists or terrorism supplies into the country.⁶³ Similarly, the threat of attacks on Coast Guard vessels or other law enforcement entities deserves consideration.⁶⁴ Ultimately, the extension of capabilities in underwater operations threatens the maritime domain awareness of the United States by shielding movement and activity in the nation's territorial waters.

Increasing underwater operations, especially those exploiting natural resources, also escalates the probability for environmental damages. As demonstrated by the Deepwater Horizon oil spill, drilling at vast ocean depths presents opportunities to access large amounts of oil, but that accessibility also multiplies the potential for environmental pollution in a catastrophic event.⁶⁵ Unlike previous incidents, Deepwater Horizon occurred thousands of feet below the surface, spilling oil into deep ocean layers with abundant marine life for which little information exists.⁶⁶ Catastrophic pollution events might occur through accidents (i.e. the Deepwater Horizon), targeted attacks by terrorists, or natural disasters like hurricanes and earthquakes.⁶⁷ Additionally, technological advancement and the growing accessibility in the Arctic region open a vast, remote region to exploration by nations and companies seeking to extract the natural resources.⁶⁸ Previous incidents and potential threats make it apparent that advancements in emergency responses are essential to protecting the environment.⁶⁹

In addition to oil, the abundance of underwater natural resources applies to other minerals and marine life.⁷⁰ Companies are actively searching to expand methods to harvest marine resources including minerals, wood, fish, and other aquatic life.⁷¹ Undiscovered marine life may provide valuable new organisms and research potential for medical purposes. As people attempt to harvest these types of resources, the increased use could produce additional pollution by

disrupting ecosystems, damaging marine life, or introducing invasive species. For example, companies extracting resources must take care not to disturb the bottom, causing aquatic environmental damage from turbidity and sediment.⁷² As with fish and other marine animals, it will be necessary to introduce laws and regulations that dictate appropriate levels and methods of harvesting. Despite regulatory efforts, the increased activity in the underwater region will introduce new environmental challenges, possibly changing the environmental dynamics.

Coast Guard Roles and Responsibilities for Underwater Issues

While apparent that the increasing underwater activity presents more hazards and threats, it is still vital to assess whether these hazards and threats overlap with Coast Guard roles and responsibilities. The Coast Guard's primary statutory role and responsibility remains maritime search and rescue.⁷³ As the lead agency for maritime search and rescue, the Coast Guard responds to mariners in immediate distress, which already includes missing or injured divers.⁷⁴ Without other federal agencies sharing primary responsibility for maritime search and rescue, it is safe to expect that the Coast Guard will be the lead agency for search and rescue involving underwater activities as well. This does not necessarily require the Coast Guard to go underwater itself for rescues, but as more people engage in underwater activities this may become the reality. Trapped, disabled, or injured submarines and divers all pose potential cases for the Coast Guard that might necessitate underwater rescues. At a minimum, the increased subsurface activity will require awareness and response by the Coast Guard, even if limited to conducting search patterns for missing vessels or ensuring broken unmanned underwater vehicles are not hazards to navigation.

In addition to maritime search and rescue responsibilities, the Coast Guard also provides critical homeland security efforts minimizing disruptions to the global system.⁷⁵ Known as ports, waterways, and coastal security, the homeland security mission of the Coast Guard involves protecting the nation and the maritime transportation system against terrorist attacks or exploitation through the maritime environment.⁷⁶ This mission already involves providing security against limited underwater threats such as divers, generally by sweeping piers for explosives during national security events.⁷⁷ As technology promotes improved capabilities for divers, submarines, and remotely operated vehicles, the increasing threat for terrorist to exploit the underwater environment demands heightened attention from the Coast Guard. Ports, waterways, and coastal security efforts also include the protection of critical infrastructure.⁷⁸ As critical infrastructure expands in the underwater environment, this role both becomes difficult and critical.

Contributing to the layers of homeland defense, a portion of the Coast Guard's responsibility involves providing maritime domain awareness.⁷⁹ Maritime domain awareness involves locating and tracking vessels or other potential threats in the maritime environment.⁸⁰ Again, the expected proliferation of underwater activity will challenge the Coast Guard's ability to achieve complete maritime domain awareness. While extensive capabilities already exist to locate and track vessels approaching the United States on the surface, the absence of sonar or other detection and tracking capabilities for underwater vessels leaves a substantial gap in the nation's maritime domain awareness.

In addition to the response aspects of ports, waterways, and coastal security, the Coast Guard also possesses prevention responsibilities for homeland security.⁸¹ Overseeing the approval of area maritime security plans, the Coast Guard works with the public and private

sector of regions to produce plans for responses to terrorist activities and natural disasters.⁸²

With the increasing potential for underwater attacks and terrorist underwater entry into the United States, the developed response plans need to incorporate counter measures and responses to the associated threats and consequences.⁸³ Coast Guard prevention roles also include efforts to implement resiliency and promote recovery to critical underwater infrastructure in the event of terrorist attacks or natural disasters.

National defense also remains an important role for the Coast Guard.⁸⁴ By working with the US Navy, the increased threats within the underwater environment may not require substantial increases to the Coast Guard's role in national defense. However, it may still be wise for the Coast Guard to possess the ability to counter potential underwater threats of concern in national defense. The ability to detect subsurface intrusions, employ countermeasures against mines, and protect the United States from attacks originating in the underwater domain could be important national defense roles for the Coast Guard in the event of war or substantial terrorist threats. Although the Navy fulfills these missions during standard times, the preoccupation of the Navy during war shifts the responsibility to the Coast Guard as occurred during World War II and Vietnam. Furthermore, depending on the primary location of the war, the potential exists that the Coast Guard will be actively engaged on the war front where underwater threats exist and require extensive knowledge, preparation, and capabilities to confront.⁸⁵ Despite the lack of a national defense underwater mission requirement for the Coast Guard, prudence suggests that the Coast Guard should still incorporate the capabilities to counter underwater activities and threats within the national defense role.

Other significant Coast Guard missions include countering and interdicting drugs and illegal alien migrants within the maritime domain.⁸⁶ Both of these missions involve stopping

criminal elements from illegally smuggling in goods and people to the United States. As demonstrated, drug trafficking organizations are steadily advancing their capabilities within the subsurface region, building vessels of various types intended to avoid detection by hiding underwater.⁸⁷ The seizure of two submarines in South America illustrates the desire of criminal elements to operate underwater and the lack of extensive intelligence in the area means it is possible that the criminal organizations already possess this capability.⁸⁸ As technology advances and becomes more affordable, smugglers of different commodities, including humans, will become increasingly likely to experiment in semi-submersible self-propelled vessels or submarines.⁸⁹ As one of the nation's primary organization responsible for combatting drug and migrant smuggling in the maritime domain, the Coast Guard retains a responsibility to counter these threats.



Figure 4. Photo of a self-propelled semi-submersible interdicted during joint law enforcement operations in September 2008. (Photograph by Telfair Brown. 080916-G-0000A-008.jpg from US Coast Guard Visual Image Gallery at <http://cgvi.uscg.mil/media/main.php>.)⁹⁰



Figure 5. Pictures of 35-foot self-propelled, semi-submersible interdicted by the US Coast Guard Cutter *Midgett*. (Photograph by Eric Chandler, 110120-G09726M-Midgett-SPSS, from US Coast Guard Visual Image Gallery at <http://cgvi.uscg.mil/media/main.php>.)⁹¹

As a federal law enforcement agency, the Coast Guard enforces federal laws and regulations within the maritime domain that include protecting marine resources.⁹² The Coast Guard's living marine resource mission primarily involves enforcing fishing regulations and laws to protect other marine animals such as Northern Right Whale zones, closed fishing areas, and devices in fishing nets to prevent the entanglement of sea turtles. Currently, other law enforcement activity involves protecting the United States' exclusive economic zone from illegal encroachment by foreign fishing vessels.⁹³ The potential extraction of natural resources from underwater operations will require law enforcement efforts as well to enforce regulations and

protect against theft of natural resources from the nation's exclusive economic zone. Although not solely responsible for developing laws and regulations to protect the nation's maritime resources, the Coast Guard serves as one of the primary agencies responsible for enforcing the laws and regulations through inspections, boardings, and surveillance. For instance, the US Navy does not have the authority to enforce laws and regulations. In the same manner, the new Bureau of Ocean Energy Management possesses oversight for offshore oil drilling, but the Coast Guard will conduct operations to support these efforts.⁹⁴ Similar situations are likely to occur within the underwater domain as well with the Coast Guard receiving some responsibility for enforcing laws and regulations developed to protect the natural resources and the exclusive economic zone from underwater operations.

Increased activity in the underwater environment presents the additional threats of environmental pollution, requiring additional preparedness by the Coast Guard as the lead organization for responding to maritime disasters.⁹⁵ Demonstrated by Deepwater Horizon, the Coast Guard serves as the lead organization for oil pollution response and recovery in the maritime environment.⁹⁶ Originating almost 5000 feet below the surface of the water, the Deepwater Horizon oil spill displays the challenges associated with underwater pollution that the Coast Guard must already handle.⁹⁷ Other similar scenarios could easily originate from underwater activities like mineral extraction that necessitate Coast Guard response to environmental pollution. Responsible for responding to maritime environmental pollution, the Coast Guard needs to prepare for responses to the higher potential of environmental issues emanating from increased underwater operations.

Significant Coast Guard's roles and responsibilities include regulatory and prevention efforts designed to prevent hazards and threats before they occur.⁹⁸ Multiple aspects of this

mission, known as marine safety, convey directly into appropriate efforts to address the expected increases in underwater activities.⁹⁹ The Coast Guard is the primary agency for enforcing laws and regulations designed to promote safety of vessels and safety on the water.¹⁰⁰ Examples include checking life jackets, flares, and lights on vessels. Additionally, the Coast Guard is responsible for inspecting commercial vessels to maintain safety standards and approving operators for carrying passengers.¹⁰¹ The expansion of vessels designed to operate under the water's surface will require similar oversight, with the Coast Guard being the agency best suited to meet this need.

Besides enforcing the laws and regulations, the Coast Guard also assists in the development of the laws and regulations.¹⁰² Providing expertise and coordinating stakeholder meetings to facilitate public feedback on proposed laws, the Coast Guard plays an important role in the development of maritime regulations promoting safety. These same efforts apply to laws facilitating safe navigation and protecting natural resources in the maritime domain.¹⁰³ As underwater operations become more prevalent, laws and regulations need to incorporate these activities. Although not the primary agency responsible for developing these laws and regulations, the Coast Guard will certainly require the expertise and knowledge of underwater operations to assist in the development of legislation to maintain safety and protect natural resources.

Furthermore, the Coast Guard currently supports waterway safety by providing systems for safe navigation.¹⁰⁴ These systems incorporate the maintenance of aids to navigation to mark channels and zones for safe operations as well as efforts like vessel traffic services coordinating movement of shipping within large ports.¹⁰⁵ Although it is unclear what type of navigation systems will be in place to coordinate underwater movement of vessels, particularly in high-

density areas, the Coast Guard will likely own a large responsibility in this activity. Because of this possibility, it will be necessary for Coast Guard personnel to possess adequate knowledge and capabilities to facilitate these types of operations.

To prevent future accidents, the Coast Guard also maintains partial responsibility for investigating maritime vessel accidents.¹⁰⁶ This primarily has involved working with the National Transportation Board to investigate incidents like sunken fishing trawlers, tanker collisions with bridges, and similar type incidents.¹⁰⁷ With the addition of extensive underwater activities, accidents involving submarines, remotely operated vehicles, and other types of vessels will require Coast Guard support to investigations. The combination of rising threats and the Coast Guard responsibilities to promote maritime safety necessitates the development of knowledge and expertise regarding underwater operations and the possession of capability to conduct investigations of underwater accidents.

Examining the likely threats emanating from increased underwater activity in the context of the roles and responsibilities of the Coast Guard demonstrates that developing a Coast Guard underwater mission set for the future is vital. The threat of accidents, smuggling or natural resource exploitation under the water's surface will pull the Coast Guard missions into the underwater domain.¹⁰⁸ The Coast Guard will likely receive primary responsibility for underwater search and rescue and countering underwater threats to ports, waterways, and coastal security. Meanwhile, other missions like counter drugs, illegal alien migrant interdiction, and protection of marine resources will be more widely shared with additional agencies, but still demand Coast Guard capacity and capability. The Coast Guard will also share responsibility for preventative efforts in response to the threats and hazards, again requiring the Coast Guard to possess knowledge and expertise of underwater activity.

Potential Solutions for Coast Guard Underwater Missions

Even as interactions in the underwater environment expand the hazards and threats that the Coast Guard must cope with, the advances in technology provides potential solutions. One of the most important aspects for the Coast Guard to remember while developing an underwater mission is that leveraging partnerships will be vitally important.¹⁰⁹ Perhaps the most important partnership for supporting the underwater mission is the US Navy.¹¹⁰ With vast experience in conducting underwater missions, including combatting threats, operating underwater, and experimenting with technology, the US Navy possesses knowledge, expertise, and capabilities that could significantly enhance the Coast Guard's efforts.¹¹¹ Partnered with the Coast Guard in the *Cooperative Strategy for 21st Century Seapower*, the US Navy also possesses a vital interest and critical role in addressing many of the potential threats.¹¹² Promoting maritime security, control of the sea, and protection of the maritime environment, the *Cooperative Strategy for 21st Century Seapower* provides a foundational basis for the partnership between the Coast Guard and Navy to address underwater threats.¹¹³ Utilizing the US Navy's sonar capabilities aboard ships, particularly those actively engaged in counter drug operations, could assist in developing awareness of subsurface maritime activity.¹¹⁴ Similarly, the Coast Guard could learn from US Navy vessels already equipped to conduct counter-mine operations and develop capabilities similar to the specialty counter mine warfare modules designed to operate from the newest Littoral Combat Ships. Additionally, the Navy previously conducted research and experimentation in designing, testing, and utilizing remotely operated vehicles for detecting mines and other underwater threats.¹¹⁵ Through an astute partnership with the Navy, the Coast Guard can integrate existing knowledge and efforts to quicken the development of organic

underwater capabilities and prevent the duplication of efforts, thereby promoting efficiency and effectiveness in combatting the potential underwater threats.

Collaboration is not limited to the US Navy. Many other organizations are actively exploiting underwater capabilities and could provide useful knowledge, expertise, and support to address the underwater challenges. The Coast Guard needs to employ an approach incorporating all elements of national power to address concerns that arise from underwater activity, particularly in providing security and countering threats from transnational criminal organizations and terrorists.¹¹⁶ Policies to accomplish these objectives need to rely upon participation throughout the international community and address social issues associated with the threats.¹¹⁷ Developing appropriate regulations for governing the extraction of natural resources requires engagement with other federal agencies such as the Department of Energy, the National Oceanographic and Atmospheric Administration, and the National Marine Fisheries Service. Active involvement with the potential stakeholders and regulatory organizations will be essential to developing the laws as well as the means for enforcement.¹¹⁸ Engagement throughout the Department of Homeland Security will also be a crucial requirement to leveraging resources and the responsibilities of other stakeholders to address the threats. For instance, working with the departments and agencies involved in the Human Smuggling and Trafficking Center will be crucial towards developing a whole of government approach to combatting the threat of smuggling terrorists into the country via submarines.¹¹⁹ To combat this possibility, the nation needs to assess the execution of antisubmarine operations against drug smugglers and terrorists.¹²⁰ Overseeing research and development, grant programs, and funding, the Department of Homeland Security plays a critical roles in the Coast Guard's development of an underwater mission and the development of potential methods for combatting these threats.

For instance, the Department of Homeland Security funded research projects through Centers of Excellence to address homeland security needs like the recording and tracking of underwater acoustic information to detect and identify vessels entering ports.¹²¹ Expanding similar research and concepts could address the underwater threats and enhance maritime domain awareness below the surface of the water.

Private sector organizations will also be critical partners for the Coast Guard in developing underwater capabilities.¹²² As discussed, universities and researchers from places like Scripps Institution of Oceanography and Woods Hole Oceanographic Institution play a vital role in the development and application of technology for underwater activities as well as methods to combat the hazards and threats. Similarly, private companies and businesses are expounding on technological capabilities for underwater activities that provide opportunities for the Coast Guard to leverage.¹²³ As private companies lead the way in many underwater activities, such as deep-water drilling, exploring ocean trenches, and conducting deep-water salvage, it is vital for the Coast Guard to incorporate the available expertise and knowledge to understand and address the potential threats and hazards while mitigating potential consequences.¹²⁴ The Coast Guard should collaborate with public and private entities to establish best practices, conduct exercises, and determine requirements for protecting critical infrastructure.¹²⁵

The technological advances and concepts increasing activity within the underwater environment also provide potential solutions to the threats and hazards for the Coast Guard. While remotely operated vehicles become more prevalent for operations like collecting environmental data, fixing underwater damage to structures, or salvaging sunken vessels, this technology also provides opportunities for the Coast Guard. The Coast Guard could incorporate

unmanned underwater vehicles to detect and neutralize mines while reducing risks to personnel as explored by the US Navy.¹²⁶ Similarly, properly designed remotely operated vehicles could conduct underwater sweeps of piers, vessels, and structures looking for bombs, hidden compartments, or other potential threats as part of the Coast Guard homeland security mission.¹²⁷ The Coast Guard could also use these types of vehicles to conduct surveillance operations within areas, identify and track potential underwater threats or determine changes in the underwater environment and structures, all while increasing maritime domain awareness.¹²⁸

Remotely operated vehicles provide the Coast Guard potential solutions to other challenges as well. For instance, unmanned underwater vehicles provide a method for capturing photographs and video in support of accident investigations.¹²⁹ Enforcing rules and regulations regarding maintenance of structures and equipment, safety features, and resource extraction efforts located underwater is difficult without some method of conducting visual inspections underwater. Remotely operated vehicles present the capability of inspecting deep or remote underwater operations by providing visual imagery back to the surface for inspection needs.¹³⁰ These types of operations could prove valuable in numerous other capacities as well for current operations. For instance, unmanned vehicles could investigate wreckage of sunken vessels to provide additional information for accident investigations or locate and recover the contents of sunken vessels for prosecuting smuggling cases.

Additionally, remotely operated vehicles have the capability to provide response capacity for underwater accidents and emergencies.¹³¹ Placing a cap over the ruptured Deepwater Horizon well required access and maneuverability in deep water beyond the capabilities of divers necessitating the use of an unmanned vehicle.¹³² Unmanned underwater vehicles could also respond to environmental disasters, detect excessive extraction of natural resources, or determine

environmental damages. Similarly, these vessels could also provide additional capacity to conduct underwater search and rescue by locating and possibly assisting mariners in distress. As the capabilities of remotely operated vehicles improve, these types of operations become easier and potentially present new methods to address the underwater threats and hazards.¹³³ Consequently, it is important for the Coast Guard to engage actively in developing knowledge and capabilities with underwater unmanned vehicles quickly in anticipation of underwater operations.

Although remotely operated vehicles will provide astounding potential for future roles and activities, requirements still exist for the Coast Guard to develop other capabilities to address threats and hazards posed by increased underwater operations. Advances in submarine technology are likely to augment the ability of manned vehicles to operate underneath the water's surface and conduct numerous operations. Manned submarines may be necessary to conduct some of the roles and responsibilities beyond the capability of remotely operated vehicles. For instance, while some rules are enforceable through video footage from unmanned vehicles, certain enforcement efforts will require active human interaction such as inspections, questioning, measurements, detaining subjects or similar actions.¹³⁴ For example, unmanned underwater vehicles might be able to identify underwater vessels in the area, but stopping the vessels and conducting searches will require human involvement. While identifying the requirements is not complete, it is likely that the Coast Guard will need at least limited manned underwater capabilities. This capacity may come through miniature submarines designed for small teams or individuals. Although national defense threats may require larger submarines, the Navy already possesses this capability and capacity that the Coast Guard can leverage.¹³⁵ As such, unless terrorist or drug organizations develop and present substantial underwater threats,

the Coast Guard would not need a fleet of large submarines, but could instead rely on smaller subs designed for special purposes.

In addition to manned submarines, the Coast Guard needs to incorporate sonar, radar, and acoustic devices capable of detection and tracking into their underwater mission capabilities for vessels and aircraft. While remotely operated vehicles provide some capacity to enhance maritime domain awareness, complete coverage would require larger systems around critical ports and threat areas.¹³⁶ These types of systems, integrated with existing surface systems, improve the Coast Guard's maritime domain awareness and counter potential underwater threats. Additionally, integrating these capabilities into existing units and platforms is imperative to achieving mission success in the underwater environment. For instance, adding sonar to Coast Guard cutters improves the ability of the Coast Guard to support national defense efforts in the event of war. This additional capability aboard cutters could also assist in other missions such as counter drugs or search and rescue by locating submerged vessels or other threats. The addition of already existing technology can quickly support early Coast Guard efforts to address underwater threats.

Ultimately, the most critical component for developing an underwater mission in the Coast Guard is promoting knowledge and expertise of the underwater environment and activities within its personnel. Since the increasing underwater threats and hazards overlap with Coast Guard roles and responsibilities, the organization's personnel will need to lead efforts to combat the threats. The Coast Guard will require knowledge of underwater vehicles, natural resources, infrastructures, and other aspects of underwater threats to manage prevention and response efforts, including development of rules and regulations. Overall, successful development of an underwater mission set in the Coast Guard relies on attaining knowledgeable personnel.

Conclusion

Advancements in technology will continue to promote underwater activity that increases threats and hazards within Coast Guard missions. As discussed by the strategic project Evergreen II, the Coast Guard anticipates that these threats and hazards will require the Coast Guard to develop underwater mission capabilities.¹³⁷ The multiple roles and responsibilities of the Coast Guard converge with the underwater threats and hazards to make the Coast Guard best suited to address the issues presented by the expanding activities in the underwater environment. Although further analysis of trends and growth in the underwater environment is necessary to determine the exact types and amounts of capabilities required, the Coast Guard needs to begin developing personnel with appropriate knowledge of underwater operations to address the challenges of the changing environment. Potential solutions are abundant, but incorporating the advancements and technological solutions requires capacity within the agency's personnel. Ultimately, the threats and hazards in the underwater environment are going to expand, requiring a response to protect the nation, its citizens, its resources, and the global economy.¹³⁸ Because of the roles and responsibilities of the Coast Guard, the Coast Guard needs to begin developing underwater mission capabilities to ensure the nation is prepared to handle the challenges associated with the expanding activity in the underwater environment. Failure to engage in the development of an underwater mission capability leaves the nation and its citizens vulnerable to potential threats and hazards with grave consequences.

¹ U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report* (Washington, DC: U.S. Coast Guard Headquarters, 2009), 49-51, <http://www.uscg.mil/STRATEGY/docs/EVERGREEN%20REPORT%20FINAL.pdf>

² U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report*, 49.

³ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement* (Washington, DC: U.S. Coast Guard Headquarters, February 2012): 23-39, <http://www.uscg.mil/posturestatement>.

⁴ Helen M. Rozwadowski, "Ocean's Depths," *Environmental History* 15, no. 3 (Jul 2010): 520-525, <http://search.proquest.com/docview/918721378?accountid=14746>.

- ⁵ Denise Russell, *Who Rules the Waves? Piracy, Overfishing and Mining the Ocean* (London: Pluto Press, 2010), 1-5, <http://site.ebrary.com/lib/usmcu/docDetail.action?docID=10479640>.
- ⁶ Michael D. Greenberg et. al., *Maritime Terrorism: Risk and Liability*, (Santa Monica, CA: RAND Corporation, 2006), 6-7, http://www.rand.org/content/dam/rand/pubs/monographs/2006/RAND_MG520.pdf.
- ⁷ Talmor Meir et. al., "Decision Learning Algorithm for Acoustic Vessel Classification," *Homeland Security Affairs* 8, (April 2012), <http://search.proquest.com/docview/1268741503?accountid=14746>.
- ⁸ Jean-Paul Rodrigue, Theo Notteboom and Brian Slack, "Maritime Transportation," in *The Geography of Transport Systems*, 3rd ed. Jean-Paul Rodrigue, Claude Comtois, and Brian Slack (New York: Routledge, 2013), <http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c4en.html>.
- ⁹ U.S. Marine Corps, U.S. Navy, and U.S. Coast Guard, *A Cooperative Strategy for 21st Century Seapower*, (Washington, DC: October 2007), <http://www.navy.mil/maritime/MaritimeStrategy.pdf>.
- ¹⁰ Levent Kirval, "International Security Through Further Modernity: A Theoretical Approach to Inland and Maritime Security," *Journal of Maritime Law & Commerce* 42, no. 1 (January 2011), 101-113, <http://search.proquest.com/docview/863657569?accountid=14746>.
- ¹¹ Russell, 84-120.
- ¹² U.S. Coast Guard, *Operations: Coast Guard Publication 3* (Washington DC: U.S. Coast Guard Headquarters, February 2012): 11-13, http://www.uscg.mil/doctrine/CGPub/CG_Pub_3_0.pdf.
- ¹³ Rozwadowski, 521.
- ¹⁴ U.S. Marine Corps, 6-15.
- ¹⁵ J. Borges de Sousa and G. Andrade Gonçalves, "Unmanned Vehicles for Environmental Data Collection," *Clean Technologies and Environmental Policy* 13, no. 2 (April 2011): 369-380, <http://search.proquest.com/docview/857696613?accountid=14746>.
- ¹⁶ Robin Kundis Craig, "Legal Remedies for Deep Marine Oil Spills and Long-Term Ecological Resilience: A Match Made in Hell," *Brigham Young University Law Review* 2011, no. 6 (2011): 1863-1897, <http://search.proquest.com/docview/922047687?accountid=14746>.
- ¹⁷ Chris Poornian, Patricia Z. Davis, and Colby Kearns McNaughton, "Impacts of Recreational Divers on Palauan Coral Reefs and Options for Management," *Pacific Science* 64, no. 4 (October 2010): 557-565, <http://search.proquest.com/docview/751268986?accountid=14746>.
- ¹⁸ Ahmed Rhif, "A Review Note for Position Control of an Autonomous Underwater Vehicle," *IETE Technical Review* 28, no. 6 (November 2011): 486-487, <http://search.proquest.com/docview/912847476?accountid=14746>.
- ¹⁹ Fateme Tohid Ardahaey, "Economic Impacts of Tourism Industry," *International Journal of Business and Management* 6, no. 8 (August 2011): 206-215, <http://search.proquest.com/docview/884463169?accountid=14746>.
- ²⁰ Lawson W Brigham, "Think Again: The Arctic," *Foreign Policy* no. 181 (Sep/Oct 2010): 71-74, <http://search.proquest.com/docview/748713640?accountid=14746>.
- ²¹ Reuters, "New soil samples prove the Arctic is ours: Russia," *Reuters*, September 20, 2007, <http://www.reuters.com/article/2007/09/20/us-russia-arctic-idUSL2082113920070920>
- ²² Robin Mackenzie and John Watts, "Robots, Social Networking Sites and Multi-User Games: Using New and Existing Assistive Technologies to Promote Human Flourishing," *Tizard Learning Disability Review* 16, no. 5 (2011): 38-47, <http://search.proquest.com/docview/914182185?accountid=14746>.
- ²³ Rhif, 486-487.
- ²⁴ de Sousa, 370.
- ²⁵ Alan Chave, "Seeding the Seafloor with Observatories," *Oceanus* 42, no. 2 (2004): 28-31, <http://search.proquest.com/docview/218575477?accountid=14746>.
- ²⁶ Daniel Cressey, "Open Water," *Nature* 478, no. 7368 (Oct 13, 2011): 174-177, <http://search.proquest.com/docview/901944802?accountid=14746>.
- ²⁷ Mackenzie, 41.
- ²⁸ Cressey, 176.
- ²⁹ Oceanering Technologies, "Mr1-rov.gif" http://www.navy.mil/navydata/nav_legacy.asp?id=291
- ³⁰ National Oceanic and Atmospheric Administration, "The ROV *Hercules* recovers the basalt recruitment block experiment that was deployed by the DSV *Alvin* submersible in 2003," http://oceanexplorer.noaa.gov/explorations/04mountains/logs/summary/media/herc_collecting_blocks.html
- ³¹ U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report*, 49-51.
- ³² Charles W. Schmidt, "Offshore Exploration to Commence in the Arctic: Can Shell's Oil-Spill Response Plans Keep Up?" *Environmental Health Perspectives* 120, no. 5 (May 2012): A194-199, <http://search.proquest.com/docview/1034566252?accountid=14746>.

-
- ³³ Brigham, 71-74.
- ³⁴ Craig, 1888.
- ³⁵ Schmidt, 195.
- ³⁶ Schmidt, 198.
- ³⁷ Robert Sandels, "An Oil-Rich Cuba?" *Monthly Review* 63, no. 4 (September 2011): 40-45, <http://search.proquest.com/docview/887913078?accountid=14746>.
- ³⁸ Brigham, p. 72.
- ³⁹ David J. Trenenbaum, "Underwater Logging: Submarine Rediscovered Lost Wood," *Environmental Health Perspectives* 112, no. 15 (November 2004): A892-895, <http://search.proquest.com/docview/222604737?accountid=14746>.
- ⁴⁰ Michael Sechrist, "Cyberspace in Deep Water: Protecting the Arteries of the Internet," *Kennedy School Review* 10, (2009/2010): 40-44, <http://search.proquest.com/docview/910300179?accountid=14746>.
- ⁴¹ Naomi Lubick, "Danger Zone," *Nature* 476, no. 7361 (August 25, 2011): 391-392, <http://search.proquest.com/docview/892966177?accountid=14746>.
- ⁴² Chave, 28-29.
- ⁴³ Lubick, 391-392.
- ⁴⁴ Chave, 29-30.
- ⁴⁵ U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report*, 49.
- ⁴⁶ U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report*, 49-50.
- ⁴⁷ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 11-13.
- ⁴⁸ Terrance G. Lichtenwald, Mara H. Steinhour, and Frank S. Perri, "A Maritime Threat Assessment of Sea Based Criminal Organizations and Terrorist Operations," *Homeland Security Affairs* 8, no. 1 (2011), <http://search.proquest.com/docview/1266215560?accountid=14746>.
- ⁴⁹ C. A. Pinto and Wayne K. Talley, "The Security Incident Cycle of Ports," *Maritime Economics & Logistics* 8, no. 3 (September 2006): 267-286, <http://search.proquest.com/docview/194565000?accountid=14746>.
- ⁵⁰ Lichtenwald, 3-4.
- ⁵¹ Michael T. McCaul, *A Line in the Sand: Countering Crime, Violence and Terror at the Southwest Border*, A Majority Report by the United States House Committee on Homeland Security Subcommittee on Oversight, Investigations, and Management, (Washington, DC: One Hundred Twelfth Congress Second Session, November 2012), 17-24, <http://homeland.house.gov/sites/homeland.house.gov/files/11-15-12-Line-in-the-Sand.pdf>
- ⁵² Sechrist, 41.
- ⁵³ Sechrist, 42.
- ⁵⁴ Arne Jernelöv, "The Threats from Oil Spills: Now, then, and in the Future," *Ambio* 39, no. 5 (July 2010): 353-366, <http://search.proquest.com/docview/856979339?accountid=14746>.
- ⁵⁵ Sechrist, 43.
- ⁵⁶ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 11-13.
- ⁵⁷ Brigham, 74.
- ⁵⁸ Lichtenwald, 13.
- ⁵⁹ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 42-44.
- ⁶⁰ McCaul, 22-23.
- ⁶¹ Lichtenwald, 2-4.
- ⁶² McCaul, 2-14.
- ⁶³ John Rollins and Liana Sun Wyler, *Terrorism and Transnational Crime: Foreign Policy Issues for Congress* (Washington, DC: Congressional Research Service, October 19, 2012): 1-14, <http://www.fas.org/sfp/crs/terror/R41004.pdf>
- ⁶⁴ Lichtenwald, 15.
- ⁶⁵ Craig, 1869.
- ⁶⁶ Craig, 1873.
- ⁶⁷ Lubick, 391.
- ⁶⁸ Schmidt, 194.
- ⁶⁹ Craig, 1895.
- ⁷⁰ Brigham, 72-73.
- ⁷¹ Trenenbaum, 894.
- ⁷² Trenenbaum, 894-895.

-
- ⁷³ U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, Coast Guard Publication 1 (Washington, DC: U.S. Coast Guard Headquarters, May 2009): 5-7, http://www.uscg.mil/doctrine/CGPub/Pub_1.pdf
- ⁷⁴ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 44-45.
- ⁷⁵ Charles C. Moore II, "Revitalizing the Cooperative Strategy for 21st Century Seapower," *Parameters* 41, no. 2 (Summer 2011): 49-61, <http://search.proquest.com/docview/909033665?accountid=14746>.
- ⁷⁶ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 4.
- ⁷⁷ Ryan N. Smith et. al., "A Geometric Approach to Trajectory Design for an Autonomous Underwater Vehicle: Surveying the Bulbous Bow of a Ship," *Acta Applicande Mathematicae* 115, no. 2 (August 2011): 209-232, <http://search.proquest.com/docview/875487763?accountid=14746>.
- ⁷⁸ U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 8-11.
- ⁷⁹ Moore, 52.
- ⁸⁰ Meir, 2012.
- ⁸¹ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 42.
- ⁸² U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 8-11.
- ⁸³ Moore, 56.
- ⁸⁴ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 5.
- ⁸⁵ Norton, 6-11.
- ⁸⁶ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 5.
- ⁸⁷ McCaul, 23-24.
- ⁸⁸ Lichtenwald, 1-6.
- ⁸⁹ Lichtenwald 6-7.
- ⁹⁰ Telfair Brown, "080916-G-0000A-008.jpg" September 12, 2008 in US Coast Guard Visual Information Gallery at http://cgvi.uscg.mil/media/main.php?g2_itemId=383971.
- ⁹¹ Eric Chandler, "110120-G-0726M-Midgett-SPSS" February 20, 201 in US Coast Guard Visual Information Gallery at http://cgvi.uscg.mil/media/main.php?g2_itemId=1147705.
- ⁹² U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 42-44.
- ⁹³ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 7-8.
- ⁹⁴ Craig, 1896.
- ⁹⁵ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 15, 44-46.
- ⁹⁶ U.S. Government Printing Office, 40 Code of Federal Regulations 300.323 <http://www.gpo.gov/fdsys/granule/CFR-2011-title40-vol28/CFR-2011-title40-vol28-sec300-323/content-detail.html>
- ⁹⁷ Schmidt, 198.
- ⁹⁸ U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 5-8.
- ⁹⁹ U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 5-8.
- ¹⁰⁰ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 42-46.
- ¹⁰¹ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 3-4.
- ¹⁰² U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 5-7.
- ¹⁰³ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 42-46.
- ¹⁰⁴ U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 7, 13-15.
- ¹⁰⁵ U.S. Coast Guard, *Operations: Coast Guard Publication 3*, 6-8.
- ¹⁰⁶ U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 7.
- ¹⁰⁷ U.S. Coast Guard, *U.S. Coast Guard: America's Maritime Guardian*, 7.
- ¹⁰⁸ Moore, 58.
- ¹⁰⁹ U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report*, 49-50.
- ¹¹⁰ McCaul, 24.
- ¹¹¹ Lichtenwald, 1-2.
- ¹¹² Moore, 49-51.
- ¹¹³ Moore, 49-50.
- ¹¹⁴ McCaul, 24.
- ¹¹⁵ Randy Walker, "Design and Evaluation of an Integrated, Self-Contained GPS/INS Shallow-Water AUV Navigation System (SANS)," (master's thesis, Naval Postgraduate School: Monterey, CA, 1996): 1-17.
- ¹¹⁶ Rollins, 34-40.
- ¹¹⁷ Levent Kirval, "International Security Through Further Modernity: A Theoretical Approach to Inland and Maritime Security," *Journal of Maritime Law & Commerce*, 42(1), (January 2011), 101-113.
- ¹¹⁸ U.S. Coast Guard, *United States Coast Guard 2012 Posture Statement*, 22-23.

-
- ¹¹⁹ Rollins, 20-25.
- ¹²⁰ Lichtenwald, 18.
- ¹²¹ Meir, 2012.
- ¹²² Sechrist, 43-44.
- ¹²³ Richard Bloss, “Robotic Watercraft Make a Big Splash at the Unmanned Vehicle Show,” *The Industrial Robot* 37, no. 3 (2010): 239-243, <http://search.proquest.com/docview/216994551?accountid=14746>.
- ¹²⁴ U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report*, 52-57.
- ¹²⁵ Sechrist, 44.
- ¹²⁶ Walker, 1-11.
- ¹²⁷ Smith, 210, 230.
- ¹²⁸ Bloss, 239-241.
- ¹²⁹ Bloss, 239.
- ¹³⁰ de Sousa, 371-374.
- ¹³¹ de Sousa, 373-378.
- ¹³² Jernelöv, 355-361.
- ¹³³ Bloss, 243.
- ¹³⁴ Bloss, 244.
- ¹³⁵ Moore, 52-53
- ¹³⁶ Meir, 2012.
- ¹³⁷ U.S. Coast Guard, *U.S. Coast Guard Evergreen II Project Report*, 49-51.
- ¹³⁸ Moore, p. 58.

Bibliography

- Ardahaey, Fateme Tohid. "Economic Impacts of Tourism Industry." *International Journal of Business and Management* 6, no. 8 (August 2011): 206-215.
<http://search.proquest.com/docview/884463169?accountid=14746>.
- Bloss, Richard. "Robotic Watercraft make a Big Splash at the Unmanned Vehicle show." *The Industrial Robot* 37, no. 3 (2010): 239-243. <http://search.proquest.com/docview/216994551?accountid=14746>.
- Brigham, Lawson W. "Think again: The Arctic." *Foreign Policy* no. 181 (Sep/Oct 2010): 71-74, 12.
<http://search.proquest.com/docview/748713640?accountid=14746>.
- Brown, Telfair. "080916-G-0000A-008.jpg" US Coast Guard Visual Information Gallery, September 12, 2008.
http://cgvi.uscg.mil/media/main.php?g2_itemId=383971.
- Chandler, Eric. "110120-G-0726M-Midgett-SPSS" US Coast Guard Visual Information Gallery, February 20, 2010. http://cgvi.uscg.mil/media/main.php?g2_itemId=1147705.
- Chave, Alan. "Seeding the Seafloor with Observatories." *Oceanus* 42, no. 2 (2004): 28-31.
<http://search.proquest.com/docview/218575477?accountid=14746>.
- Craig, Robin Kundis. "Legal Remedies for Deep Marine Oil Spills and Long-Term Ecological Resilience: A Match made in Hell." *Brigham Young University Law Review* 2011, no. 6 (2011): 1863-1897.
<http://search.proquest.com/docview/922047687?accountid=14746>.
- Cressey, Daniel. "Open Water." *Nature* 478, no. 7368 (Oct 13, 2011): 174-177.
<http://search.proquest.com/docview/901944802?accountid=14746>.
- de Sousa, J. Borges and G. Andrade Gonçalves. "Unmanned Vehicles for Environmental Data Collection." *Clean Technologies and Environmental Policy* 13, no. 2 (2011): 369-380.
<http://search.proquest.com/docview/857696613?accountid=14746>.
- Greenberg, Michael D., Peter Chalk, Henry H. Willis, Ivan Khiko, and David S. Ortiz. *Maritime Terrorism: Risk and Liability*. Santa Monica, CA: RAND Corporation, 2006.
http://www.rand.org/content/dam/rand/pubs/monographs/2006/RAND_MG520.pdf.
- Jernelöv, Arne. "The Threats from Oil Spills: Now, then, and in the Future." *Ambio* 39, no. 5 (July 2010): 353-66.
<http://search.proquest.com/docview/856979339?accountid=14746>.
- Kirval, Levent. "International Security through further Modernity: A Theoretical Approach to Inland and Maritime Security." *Journal of Maritime Law and Commerce* 42, no. 1 (January 2011): 101-113.
<http://search.proquest.com/docview/863657569?accountid=14746>.
- Lichtenwald, Terrance G., Mara H. Steinhour, and Frank S. Perri. "A Maritime Threat Assessment of Sea Based Criminal Organizations and Terrorist Operations." *Homeland Security Affairs* 8, no. 1 (2011).
<http://search.proquest.com/docview/1266215560?accountid=14746>.
- Mackenzie, Robin and John Watts. "Robots, Social Networking Sites and Multi-User Games: Using New and Existing Assistive Technologies to Promote Human Flourishing." *Tizard Learning Disability Review* 16, no. 5 (2011): 38-47. <http://search.proquest.com/docview/914182185?accountid=14746>.
- McCaul, Michael T. *A Line in the Sand: Countering Crime, Violence and Terror at the Southwest Border*. A Majority Report by the United States House Committee on Homeland Security Subcommittee on Oversight, Investigations, and Management. Washington, DC: One Hundred Twelfth Congress Second

-
- Session, November 2012. <http://homeland.house.gov/sites/homeland.house.gov/files/11-15-12-Line-in-the-Sand.pdf>.
- Meir, Talmor, Mikhail Tsionskiy, Alexander Sutin, and Hady Salloum. "Decision Learning Algorithm for Acoustic Vessel Classification." *Homeland Security Affairs* 8, (April 2012).
<http://search.proquest.com/docview/1268741503?accountid=14746>.
- Moore, Charles C. II. "Revitalizing the Cooperative Strategy for 21st Century Seapower." *Parameters* 41, no. 2 (Summer 2011): 49-61. <http://search.proquest.com/docview/909033665?accountid=14746>.
- National Oceanic and Atmospheric Administration. "The ROV *Hercules* recovers the basalt recruitment block experiment that was deployed by the DSV *Alvin* submersible in 2003."
http://oceanexplorer.noaa.gov/explorations/04mountains/logs/summary/media/herc_collecting_blocks.html
- Norton, Davalee G. "'Forward...from the sea,' Where does the Coast Guard Fit in?" Master's thesis, Naval War College, 1996.
- Oceaneering Technologies. "Mr1-rov.gif." http://www.navy.mil/navydata/nav_legacy.asp?id=291
- Pinto, C. A. and Wayne K. Talley. "The Security Incident Cycle of Ports." *Maritime Economics & Logistics* 8, no. 3 (September 2006): 267-286. <http://search.proquest.com/docview/194565000?accountid=14746>.
- Poonian, Chris, Patricia Z. R. Davis, and Colby Kearns McNaughton. "Impacts of Recreational Divers on Palauan Coral Reefs and Options for Management." *Pacific Science* 64, no. 4 (2010): 557-565.
<http://search.proquest.com/docview/751268986?accountid=14746>.
- Reuters. "New soil samples prove the Arctic is ours: Russia." *Reuters*, September 20, 2007.
<http://www.reuters.com/article/2007/09/20/us-russia-arctic-idUSL2082113920070920>.
- Rhif, Ahmed. "A Review Note for Position Control of an Autonomous Underwater Vehicle." *IETE Technical Review* 28, no. 6 (November 2011): 486-492.
<http://search.proquest.com/docview/912847476?accountid=14746>.
- Rodrigue, Jean-Paul, Theo Notteboom and Brian Slack. "Maritime Transportation." In *The Geography of Transport Systems*. 3rd ed., edited by Jean-Paul Rodrigue, Claude Comtois, and Brian Slack. New York: Routledge, 2013. <http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c4en.html>.
- Rollins, John and Liana Sun Wyler. *Terrorism and Transnational Crime: Foreign Policy Issues for Congress*. Washington, DC: Congressional Research Service, October 19, 2012.
<http://www.fas.org/crs/terror/R41004.pdf>.
- Rozwadowski, Helen M. "Ocean's Depths." *Environmental History* 15, no. 3 (July 2010): 520-525.
<http://search.proquest.com/docview/918721378?accountid=14746>.
- Russell, Denise. *Who Rules the Waves? Piracy, Overfishing and Mining the Ocean*. London: Pluto Press 2010.
<http://site.ebrary.com/lib/usmcu/docDetail.action?docID=10479640>.
- Sandels, Robert. "An Oil-Rich Cuba?" *Monthly Review* 63, no. 4 (September 2011): 40-45.
<http://search.proquest.com/docview/887913078?accountid=14746>.
- Schmidt, Charles W., M.S. "Offshore Exploration to Commence in the Arctic: Can Shell's Oil-Spill Response Plans Keep Up?" *Environmental Health Perspectives* 120, no. 5 (May 2012): A194-199.
<http://search.proquest.com/docview/1034566252?accountid=14746>.

-
- Sechrist, Michael. "Cyberspace in Deep Water: Protecting the Arteries of the Internet." *Kennedy School Review* 10, (2009/2010): 40-44. <http://search.proquest.com/docview/910300179?accountid=14746>.
- Smith, Ryan N., Dario Cazzaro, Luca Invernizzi, Giacomo Marani, Song K. Choi, and Monique Chyba. "A Geometric Approach to Trajectory Design for an Autonomous Underwater Vehicle: Surveying the Bulbous Bow of a Ship." *Acta Applicandae Mathematicae* 115, no. 2 (August 2011): 209-232. <http://search.proquest.com/docview/875487763?accountid=14746>.
- Tenenbaum, David J. "Underwater Logging: Submarine Rediscovered Lost Wood." *Environmental Health Perspectives* 112, no. 15 (November 2004): A892-895. <http://search.proquest.com/docview/222604737?accountid=14746>.
- U.S. Coast Guard. *Operations: Coast Guard Publication 3*. Washington DC: U.S. Coast Guard Headquarters, February 2012. http://www.uscg.mil/doctrine/CGPub/CG_Pub_3_0.pdf.
- U.S. Coast Guard. *U.S. Coast Guard: America's Maritime Guardian*, Coast Guard Publication 1. Washington, DC: U.S. Coast Guard Headquarters, May 2009. http://www.uscg.mil/doctrine/CGPub/Pub_1.pdf.
- U.S. Coast Guard. *U.S. Coast Guard Evergreen II Project Report*. Washington, DC: Coast Guard Headquarters, 2009. <http://www.uscg.mil/STRATEGY/docs/EVERGREEN%20REPORT%20FINAL.pdf>.
- U.S. Coast Guard. *United States Coast Guard 2012 Posture Statement*. Washington, DC: U.S. Coast Guard Headquarters, February 2012. <http://www.uscg.mil/posturestatement>.
- U.S. Government Printing Office. 40 Code of Federal Regulations 300.323. <http://www.gpo.gov/fdsys/granule/CFR-2011-title40-vol28/CFR-2011-title40-vol28-sec300-323/content-detail.html>
- U.S. Marine Corps, U.S. Navy, and U.S. Coast Guard. *A Cooperative Strategy for 21st Century Seapower*. Washington, DC: October 2007. <http://www.navy.mil/maritime/MaritimeStrategy.pdf>.
- Walker, Randy. "Design and Evaluation of an Integrated, Self-Contained GPS/INS Shallow-Water AUV Navigation System (SANS)" Master's thesis, Naval Postgraduate School: Monterey, CA, 1996.